PRELIMINARY DISCUSSION OF VENTILATION TERMINOLOGY

VENTILATION TERMINOLOGY

I. GENERAL VENTILATION OVERVIEW

McQuiston & Parker, "Heating, Ventilating and Air Conditioning" (3d ed. 1988) discusses ventilation in the following general terms:

> The dominating function of outdoor air is to control air quality, and spaces that are more or less continuously occupied require some outdoor air. Research shows that the required outdoor air is dependent on the rate of contaminant generation and the maximum acceptable contaminant level. Misunderstanding of these factors has led to considerable confusion in the past concerning the quantity of outdoor air required. It can generally be stated that in most cases more outdoor air than necessary is supplied. However, some overzealous attempts to save energy through reduction of outdoor air have caused poor-quality indoor air. ASHRAE Standard 62 (10) defines acceptable air quality as ambient air in which there are no known contaminants at harmful concentrations and with which a substantial majority of the people exposed do not express dissatisfaction. Standard 62 defines ventilation requirements and specifies allowable contaminant concentrations for ventilation air. Table 4-2, reprinted from Standard 62, prescribes the basic requirements for acceptable air quality and Table 4-3, also from Standard 62, gives the minimum outdoor air requirements. Standard 62 should be consulted for additional details and definitions. However, some critical definitions will be considered before proceeding. *Ventilation air* is the combination of outdoor air, of acceptable quality, and recirculated air from the conditioned space that after passing through the air-conditioning unit becomes *supply air*. The ventilation air may be 100 percent outdoor air. The term *makeup* air may be used synonymously with *outdoor* air and the terms *return* and *recirculated* air are often used interchangeably.
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> The discussion here pertains to the required ventilation air to maintain indoor air quality. A situation could exist where the

supply air required to match the heating or cooling load is greater than the ventilation air. In that case an increased amount of air would be recirculated to meet this condition.

Standard 62 describes two procedures by which indoor air quality may be controlled. The first, known as the *Ventilation Rate Procedure*, achieves indoor air quality indirectly by prescribing the minimum amount of ventilation air and various means to condition that air. The second approach, known as the *Indoor Air Quality Procedure*, specifies maximum permissible concentrations of certain contaminants in indoor air but does not prescribe ventilation rates or air treatment methods. The ventilation rate procedure is the most commonly used approach.

The Ventilation Rate Procedure has five elements.

1. Acceptable outdoor air quality.
2. Outdoor air treatment.
3. Minimum ventilation rates.
4. Criteria for reduction of outdoor air when mixed with recirculated air.
5. Criteria for noncontinuous ventilation.

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Indoor air quality is considered acceptable when the required rates of acceptable outdoor air . . . are provided.

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In some cases exhaust air from one space can be used as supply air to another space where different contaminants are generated (corridors and office spaces exhausted through toilet rooms, or dining areas exhausted through kitchens); this air is considered equivalent to acceptable outdoor air.

II. EPA DEFINITIONS

The EPA publication Building Air Quality EPA/400/1-91/033 defines several terms as follows:

- **Air Exchange Rate** — Used in two ways: 1) the number of times that the outdoor air replaces the volume of air in a building per unit time, typically expressed as air changes per hour; 2) the number of times that the ventilation system replaces the air within a room or area within the building.

- **Conditioned Air** — Air that has been heated, cooled, humidified, or dehumidified to maintain an interior space within the "comfort zone." (Sometimes referred to as "tempered" air.)

- **Exhaust Ventilation** — Mechanical removal of air from a portion of a building (e.g., piece of equipment, room, or general area).

- **Make-up Air** — Air brought into a building from outdoors through the ventilation system and that has not been previously circulated through the system.

- **Negative Pressure** — Condition that exists when less air is supplied to a space than is exhausted from the space, so the air pressure within that space is less than that in surrounding areas.

- **Positive Pressure** — Condition that exists when more air is supplied to a space than is exhausted, so the air pressure within that space is greater than that in surrounding areas.

- **Static Pressure** — Condition that exists when an equal amount of air is supplied to and exhausted from a space. At static pressure, equilibrium has been reached.

- **Ventilation Air** — Defined as the total air, which is a combination of the air brought into the system from the outdoors and the air that is being

recirculated within the building. Sometimes, however, used in reference only to the air brought into the system from the outdoors.

III. ASHRAE DEFINITIONS

ASHRAE definitions from Standard 62-1989 currently include the following ventilation related definitions:

- **acceptable Indoor air quality:** air in which there are no known contaminants as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction.
- **air conditioning:** the process of treating air to meet the requirements of a conditioned space by controlling its temperature, humidity, cleanliness, and distribution.
- **air, exhaust:** air removed from a space and not reused therein.
- **air, makeup:** outdoor air supplied to replace exhaust air and exfiltration.
- **air, outdoor:** air taken from the external atmosphere and, therefore, not previously circulated through the system.
- **air, recirculated:** air removed from the conditioned space and intended for reuse as supply air.
- **air, return:** air removed from a space to be then recirculated or exhausted.
- **air, supply:** that air delivered to the conditioned space and used for ventilation, heating, cooling, humidification, or dehumidification.
- **air, transfer:** the movement of indoor air from one space to another.

- **air, ventilation:** that portion of supply air that is outdoor air plus any recirculated air that has been treated for the purpose of maintaining acceptable indoor air quality.

- **exfiltration:** air leakage outward through cracks and interstices and through ceilings, floors, and walls of a space or building.

- **infiltration:** air leakage inward through cracks and interstices and through ceilings, floors, and walls of a space or building.

- **natural ventilation:** the movement of outdoor air into a space through intentionally provided openings, such as windows and doors, or through nonpowered ventilators or by infiltration.

- **ventilation:** the process of supplying and removing air by natural or mechanical means to and from any space. Such air may or may not be conditioned.

IV. A REVIEW OF CONGRESSIONAL TREATMENT OF VENTILATION DEFINITIONS

A search was undertaken of federal statutes to see if Congress has ever defined "separate ventilation" or "separate exhaust." These terms apparently have not been defined by Congress. Ventilation appears to be of concern primarily in statutes dealing with coal mines and with assigning responsibility over ventilation in the House and Senate to the Capitol Architect. Coal mining legislation links ventilation to the concept of "separate" but does not define such language ("Each mechanized mining section shall be ventilated with a separate split of intake air ..." 30 U.S.C.A. § 863(r)). A check of the implementing regulations on coal mine safety also failed to reveal any enlightening definitions.

The GSA regulations on Federal Property Management were also checked to see if these concepts had been defined therein.[1] Although the GSA regulations do not provide further definitions, they do refer to Department of Energy (DOE) regulations which define "ventilation" as:

> the process of supplying or removing air by natural or mechanical means to or from any space. Such air may or may not have been conditioned.

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[1] The GSA regulations contain a chart linking building standards to various building functions. Under the designation for "laboratories," the following language appears:

> Heating, ventilation and air-conditioning--As required, special building equipment to treat and exhaust to the atmosphere noxious or offensive gases produced by agency program equipment will be provided. In addition, fresh air suitable to meet the special requirements, up to 100 percent fresh air ... will be provided.

41 C.F.R. pt. 101-21, Subch. D, App. The chart also indicates a recognition of special treatment that must be accorded the air in "private toilets, clinics and health facilities" and in "food service areas." HVAC systems serving these areas must be "capable of providing an acceptable operating environment." For toilet rooms, HVAC systems should be capable of removing odors. Id. "Separately zoned and controlled" HVAC systems are required for such facilities as "Conference and Classroom/Training Facilities," "Hearing Rooms--Judiciary" and "Judicial Chambers-- U.S. Courts." Id.

The Department of Energy defines a "zone" as "a space or group of spaces within a building with heating, cooling, and/or lighting requirements sufficiently similar so that desired conditions can be maintained throughout by a single control device." 10 C.F.R. § 435.99.

10 C.F.R. § 435.99. -

The DOE regulations also define "ventilation air" as:

> that portion of supply air which comes from outside (outdoors) plus any recirculated air that has been treated to maintain the desired quality of air within a designated space. (See also Outdoor Air.)

Id. "Outdoor air" is defined as "air taken from the exterior of the building that has not been previously circulated through the building." Id.

These definitions appear in regulations that set voluntary HVAC performance standards for new construction and mandatory standards for federal buildings. The focus of the standards is energy conservation. The section on HVAC system design[2] contains a requirement that separate HVAC systems be "considered to serve areas expected to operate on widely differing operating schedules or design conditions." Id. at § 435.107, 7.2.2.1.

[2] "HVAC system" is defined in the DOE regulations as "the equipment distribution network and terminals that provide either collectively or individually the processes of heating, ventilating, and/or air conditioning to a building." 10 C.F.R. § 435.99.

V. THE OSHA RFI DOCKET

With regard to private organizations the OSHA docket was reviewed and found references by several groups to the use of separate ventilation or negative pressure (see discussion, infra). To supplement the search, a NEXIS search was run on the Chamber of Commerce of the United States, the Chemical Manufacturers Association, the Cosmetic, Toiletry and Fragrance Association, the Fragrance Foundation, and the National Paint and Coatings Association to see if any had made a public statement supporting the use of separate ventilation or exhaust, or negative pressure to improve IAQ. The search found no such references.

The New York Public Employees Federation (AFL-CIO) discusses the use of depressurization techniques to control radon in a building. (OSHA RFI Docket 3-444)

An AFSCME (AFL-CIO) submission to the docket contains a fact sheet on ventilation which describes "local ventilation" as follows:

> Local ventilation is used to remove chemicals before they get into workroom air. A local ventilation system consists of a hood, ducts to carry the fumes away, a fan to move the air, and an air cleaner to protect the air outside the plant.

An additional AFSCME document states:

> The problems of exposure to toxic substances in the office may be made worse by new energy-saving building designs and techniques. When not enough fresh air is brought into the building, there can be a hazardous build-up of carbon monoxide, cigarette smoke and other pollutants.
>
> Some office machines that release potentially toxic substances (such as copiers) may need individual ventilation systems. That's also true of major cleaning operations in which toxic chemicals are used. Where possible, operations that release toxic fumes should be placed in a separate, well-ventilated room.

(emphasis added) (OSHA RFI Docket 3-446)

The Dow Chemical Co. submission responds to the specific questions posed by OSHA in the following way:

Q: What physical evidence might trigger an IAQ investigation?

A: Experience at Dow indicates that the following might trigger an investigation:

...

- Smokers' room without separate ventilation or air cleaner causing the PTS to be recirculated throughout the building;

...

Q: Do you consider the specific type of work environment in determining the appropriate quantity of fresh air to introduce:

A: In some buildings, additional air is brought into smoking lounges, but this is usually done by putting the lounge under negative pressure and exhausting air from the lounge directly to the outdoors.

...

Q: In your opinion or from your experience, are there specific workplaces where it would not be feasible to comply with a standard that consists of any of the following: a) smoking in designated areas only, b) smoking in a designated area with separate ventilation, c) limited exposure to specific levels of PTS components, d) a total smoking ban in indoor work areas?

A: Our smoking policy and visions have employed either options (a) smoking in designated areas only, (b) smoking in a designated area with separate ventilation, or (d) a total smoking ban in indoor work areas. These have been employed and are continuing to be implemented throughout our facilities with success....

(OSHA RFI Docket 3-502)

The submission from the American Federation of Government Employees (AFL-CIO) refers to the functions of a properly designed HVAC system as including the isolation or dilution of odors and contaminants to acceptable levels through "pressure control, filtration, and exhaust fans." (OSHA RFI Docket 3-529)

The Service Employees International Union (AFL-CIO) submission contains the following comments:

Smoking areas should be physically separated and be ventilated directly to the outside to prevent second-hand smoke from passing to the non-smoking areas.

Ventilation directly to the outside should be provided for areas where machinery, kitchens, or smokers are located.

[from draft regulations in New Jersey] When processes that generate contaminants are added to a building, the owner shall consider whether N.J.A.C. 5:23-3.20 Mechanical Subcode Section M 1603.4, which prohibits air recirculation now applies. Examples of such processes may include spirit duplicators, blue print copiers, signature machines, duplicating machines, laser printers and smoking.

[from an MMWR document on tuberculosis control] In high-risk settings, certain techniques can be applied to prevent or to reduce the spread of infectious droplet nuclei into the general air circulation. ...[options include "Local exhaust

ventilation"] The exhaust fan should maintain negative pressure in the booth with respect to adjacent areas, so that air flows into the booth. ...Ideally, the air from these booths should be exhausted directly to the outside of the building.

Smoking should be banned in the building. If not feasible, then a separate room or rooms should be reserved for smoking. Such a facility should have an exclusive ventilation system.

(OSHA RFI Docket 3-630)

NIOSH states in its submission to the OSHA RFI Docket on IAQ Issues:

The most direct and effective method of eliminating ETS from the workplace is to prohibit smoking in the workplace. Until that is achieved, employers can designate separate, enclosed areas for smoking, with separate ventilation. Air from this area should be exhausted directly outside and not recirculated within the building or mixed with the general dilution ventilation for the building. Ventilation of the smoking area should meet general ventilation standards, and the

smoking area should have slight negative pressure to ensure airflow into the area rather than back into the airspace of the workplace [ASHRAE 1989].

(OSHA RFI Docket 3-689)

The Air Conditioning Contractors of America submission contains the following comment:

Regarding tobacco smoking, the increasing number of ordinances prohibiting smoking in buildings addresses this concern. In other cases, separate indoor smoking areas should be separately ventilated.

(OSHA RFI Docket 3-706)

The submission of the Business Council on Indoor Air (BCIA) includes a reference to a study showing that isolation rooms in hospitals should be under negative air pressure. The BCIA response also observes that HVAC systems should provide for exhaust "from known indoor pollution sources such as photocopiers and cooking ovens." (OSHA RFI Docket 3-933)